

Mineral of the Month Club December 2015

OPAL (var. COMMON, subvar. HYALITE)

This month our featured mineral is the hyalite subvariety of common opal from a newly discovered locality in Zacatecas, Mexico. Our write-up explains the mineralogy and origin of hyalite, its classification as a mineraloid, and its unusual daylight fluorescence.

OVERVIEW

PHYSICAL PROPERTIES

Chemistry: $\text{SiO}_2 \cdot n\text{H}_2\text{O}$ Hydrus Silicon Dioxide, always containing varying amounts of water; sometimes with traces of iron and aluminum. The hyalite subvariety of common opal contains traces of uranium.

Class: Silicates

Subclass: Tectosilicates (Framework Silicates)

Group: Hydrated Tectosilicates

Subgroup: Opal

Crystal System: None

Crystal Habits: None; usually occurs as amorphous, botryoidal fillings or coatings in fissures, fractures, and vugs.

Color: Colorless and white to yellow, red, pink, brown, green, gray, violet, and blue; precious opal is opalescent and exhibits an internal play of color over the entire spectral range; common opal has a wide range of base colors, but lacks opalescence. The hyalite subvariety of common opal is usually colorless, but occasionally exhibits subtle shades of green, yellowish-green, or yellow; it also fluoresces a pale, but distinct, greenish-yellow in daylight.

Luster: Vitreous to dull

Transparency: Most opal is translucent; the hyalite subvariety of common opal is usually transparent.

Streak: White

Cleavage: None

Fracture/Tenacity: Conchoidal; brittle.

Hardness: 5.5-6.0

Specific Gravity: Varies with water content from 1.9 to 2.3; the average specific gravity of all opal is 2.09. The specific gravity of hyalite is approximately 2.2; because of its low water content, it is among the densest of types of opal.

Luminescence: Most opal fluoresces pale greenish-yellow in shortwave ultraviolet light and white in long-wave ultraviolet light. The hyalite subvariety of common opal fluoresces vivid green in all ultraviolet wavelengths; it also fluoresces pale greenish-yellow in daylight.

Refractive Index: 1.44-1.46

Distinctive Features and Tests: The best field identification marks for opal are low density, conchoidal fracture, and lack of crystal faces and cleavage planes. The precious variety is opalescent; the hyalite subvariety of common opal is transparent

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and occurs in botryoidal masses that fluoresce pale greenish-yellow in daylight.
Dana Mineral-Classification Number: 75.2.1.1

NAME: The word “opal,” pronounced “OH-pul,” comes from the Latin *opalus*,” which stems from the Sanskrit *upala*, meaning “stone” or “jewel.” Opal, also known as “opalite” and “gel-quartz,” appears in European mineralogical literature as *opolo* and *opale*. Precious opal exhibits a fiery play of light called “opalescence”; common opal is not opalescent. Opal has many alternative and variety names. “Black opal” is dark; “honey opal” is yellow; “milk opal” is translucent and white; “porcelain opal” or “cacholong” is opaque and white; “prase opal” is green; and “blue opal” is blue or blue-green. Precious opal is also known as “fire opal,” “flash opal,” “harlequin opal,” and “pinfire opal.” “Agate opal” has alternating layers of agate and opal; “wood opal” is opalized wood; “wax opal” is waxy and yellow-brown; and “hydrophane” opal becomes nearly transparent when immersed in water. The hyalite subvariety of common opal is transparent and usually colorless. The name “hyalite,” pronounced HI-ahl-ite, stems from the Greek word *hyalos*, meaning “glass” or “glass-like.” Hyalite is also known as “water opal,” “glass opal,” “jelly opal,” and “water stone,” names that allude to both its transparency and its bubble-like, surface structure. Other alternative names for hyalite include “jalite,” “Müller’s glass,” “gummenstein,” “satin opal,” and “color-change opal.” Hyalite should not be confused with “hyalithe,” which is a trade name for a synthetic, opaline glass.

COMPOSITION & STRUCTURE: Opal is not technically a mineral, but a mineraloid, a natural, mineral-like material that lacks the crystal structure and definite chemical composition necessary for classification as a mineral. Opal is an amorphous, layered, solidified, colloidal silica gel that contains varying amounts of water attached as water of hydration. The general chemical formula $\text{SiO}_2 \cdot n\text{H}_2\text{O}$ identifies opal as hydrous silicon dioxide that contains the elements silicon, oxygen, and hydrogen. Precious opal consists of randomly arranged, hydrated silica molecules interspersed with layers of microscopic silica spherules that reflect fiery, opalescent flashes of light; common opal, which lacks opalescence, occurs in many base colors. Unlike crystalline minerals that precipitate on a molecule-by-molecule basis, opal forms when silica gels solidify or “freeze” into layered masses. As a low-temperature (epithermal) silicate, opal develops as amorphous fracture and cavity fillings in both sedimentary and volcanic environments. Unlike other types of opal, the hyalite subvariety of common opal forms from a gas phase when silica-rich gases condense into silica gel, then subsequently solidify into hyalite. Hyalite, one of the least-hydrated types of opal, contains only between three and eight percent water. It also contains traces of uranium that explain its intense, ultraviolet fluorescence and its greenish-yellow, daylight fluorescence, the latter a rare phenomenon in other minerals or mineraloids. Most hyalite consists only of silica and water and is colorless. The pale green, greenish-yellow, and yellow hues in some hyalite specimens are thought to be caused by traces of iron.

COLLECTING LOCALITIES: Precious and common opal is found in many localities worldwide. The hyalite subvariety of common opal is collected in Mexico, Afghanistan, Brazil, Canada, China, the Czech Republic, Pakistan, Switzerland, and Japan. In the United States, hyalite is found in California, New Hampshire, Montana, North Carolina, Idaho, and Utah.

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HISTORY, LORE & USES: Because of the opalescence of the precious variety and the soft, translucent colors of the common variety, opal has served as a gemstone since antiquity. Opal is cut into cabochons to best display its colors. Although known since antiquity, the hyalite subvariety of common opal was long confused with similar-appearing, colorless and transparent minerals. Hyalite was formally named in the 1790s, when mineralogists differentiated it from quartz by its lack of a crystal structure. Opal is the birthstone for October; it is also Australia's national gemstone and one of Nevada's two state gemstones. Metaphysical practitioners believe that opal wards off disease and enhances love between faithful lovers. However, because opal intensifies all thoughts and actions, including those that are negative, it must be worn judiciously. The only transparent opal, hyalite is considered a scrying or divination stone that produces visions of both past and future. When using hyalite as a scrying stone, metaphysical practitioners report that visions are preceded by the appearance of a luminous, tunnel-like opening. Hyalite is thought to inspire creativity, enhance talent, and attract success; it also serves as a talisman for artists, healers, and philosophers. Transparent hyalite is occasionally faceted into gems as large as three carats and mounted in rings. More commonly, however, botryoidal masses of transparent hyalite are mounted in prong-type, silver settings for wear as pendants. These hyalite gems are not polished, but retain their natural, lustrous, bubble-like, botryoidal surface.

ABOUT OUR SPECIMENS: Our hyalite specimens are from the state of Zacatecas in north-central Mexico. Our specimens formed from silica-laden gases emitted by masses of rhyolitic magma. These gases circulated through the cooling rhyolite and the adjacent granitic host rock to fill vugs, fissures, and fractures where, because of reduced temperature and pressure, they condensed into silica gel and subsequently solidified into hyalite. Our specimens are on a matrix of altered granite, indicating that the rhyolitic magma had intruded and fractured a body of granite prior to the formation of the hyalite. The source of our hyalite specimens was discovered in 2013, but its exact location has not yet been revealed. Hyalite specimens from this source were first publicly displayed the following year at the Tucson Gem & Mineral Show in Tucson, Arizona, where their unusual daylight fluorescence attracted attention among collectors. Under both incandescent and fluorescent artificial light, our hyalite specimens appear almost colorless. But when viewed in the light of day, they exhibit a pale, distinct, greenish-yellow hue that is caused by daylight fluorescence, a phenomenon that is rare in other minerals or mineraloids. Hyalite's daylight fluorescence and its unusually intense, ultraviolet fluorescence are caused by traces of uranium.

COMPREHENSIVE WRITE-UP

COMPOSITION & STRUCTURE

Opal has been featured several times previously as a Mineral of the Month, most recently in 2014 (pink common opal from Peru) and 2010 (boulder opal from Australia). This month we are featuring a very unusual type of opal—the transparent hyalite variety of common opal that exhibits a rare daylight fluorescence.

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Opal is technically a mineraloid, a natural, mineral-like material with distinctive properties, but lacking the definite chemical composition and crystal structure necessary for classification as a mineral. It is an amorphous, layered, solidified, colloidal silica gel consisting of randomly arranged, hydrated silica molecules interspersed with layers of microscopic silica spherules. Nevertheless, because opal was historically thought to be a mineral, it is assigned the Dana mineral-classification number 75.2.1.1. This number identifies opal as a tectosilicate (75); the subclassification (2) defines it as a tectosilicate containing water or such organic components as carbon (C) and methane (CH₄). Opal is then assigned to the opal group (1) as the first (1) and only member.

As defined by its chemical formula SiO₂·nH₂O, opal is hydrous silicon dioxide containing the elements silicon (Si), oxygen (O), and hydrogen (H). Opal's molecular weight and the proportions of its elemental components vary with the amount of water (H₂O) present. Opal can contain between 1 percent and 30 percent water. The molecular weight of an opal specimen with the empirical formula SiO₂·H₂O, for example, would contain about 36 percent silicon, 62 percent oxygen, and 2 percent hydrogen; water would account for roughly 22 percent of its molecular weight.

In opal's chemical formula SiO₂·nH₂O, the “·n H₂O” indicates a variable number of attached water molecules. These water molecules, called “water of hydration,” consist of electrically neutral water molecules that are attached by weak hydrogen bonding and do not affect the electrical balance of the parent molecule. In the water molecule H₂O, one oxygen ion O²⁻ shares electrons and covalently bonds to two hydrogen ions 2H¹⁺. Because the two small hydrogen ions are grouped together, the water molecule is asymmetrical. The two hydrogen ions retain a small positive charge, while the opposite side of the molecule, dominated by the large, negatively charged oxygen ion, retains a residual negative charge. Hydrogen or polar bonding occurs when the faintly positive poles of water molecules are attracted to the negatively charged electrons of other atoms. In opal, the positively charged sides of water molecules are attracted to the negatively charged oxygen ions within the silica tetrahedra. The hyalite subvariety of common opal, one of the least hydrated types of opal, contains only between three and eight percent water, meaning that only about one water molecule of water is present for every ten molecules of silica.

Opal's basic building block is the silica tetrahedron (SiO₄)⁴⁻, which consists of a silicon atom surrounded by four equally spaced oxygen atoms positioned at the corners of a tetrahedron. Opal is subclassified as a tectosilicate or “framework” silicate, in which oxygen ions share electrons with oxygen ions of adjacent tetrahedra to form rigid, repeating, compact, three-dimensional, framework-type structures. The tectosilicates include quartz [silicon dioxide, SiO₂], which is similar to opal only in that it also contains silica tetrahedra. But unlike quartz, opal has no orderly, repeating atomic structure and thus no crystal form. Opal and quartz also differ considerably in their physical properties. With its rigid crystal structure, tight atomic packing, and strong covalent bonding, quartz has a substantial Mohs hardness of 7.0. But since it lacks a rigid crystal structure, opal is softer at Mohs 5.5-6.0 and much more brittle. Opal is also substantially less dense (average specific gravity 2.09) than quartz (specific gravity 2.65).

Most opal forms as fracture and cavity fillings when silica gel solidifies; its formation does not involve a gas phase. Opal, which is relatively abundant and found worldwide, occurs in both

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volcanic and sedimentary environments. Volcanic opal forms when silica solutions fill fissures and cavities in volcanic host rocks. The rarer sedimentary opal forms when water circulates through sandstone to dissolve quantities of silica to create silica gels which solidify into solid opal. The formation of hyalite, however, is unique because it involves a gas phase. Hyalite forms exclusively in or near emplacements of rhyolite, a silica-rich, volcanic rock. When extruded rhyolitic lava begins to cool and solidify, gases rich in silica and water migrate through the cooling rhyolite and adjacent rock masses. When these gases collect in vugs, fissures, or fractures with reduced temperature and pressure, they condense first from a gas to a liquid, then solidify into bubble-like, botryoidal crusts of hyalite.

Gemologically, opal is classified into two varieties: precious and common. Precious opal exhibits opalescence; common opal does not. Opalescence refers to an iridescent, rainbow-like play of light called “fire,” which is caused by the interaction of light with layers of tiny silica spherules less than $1/1,000^{\text{th}}$ of a millimeter in diameter. Common (non-opalescent) opal either lacks these silica-spherule structures or contains spherules that are too large or too small to diffract light.

Opal is also classified into four structural groups:

Opal-C is common opal consisting of attached water molecules interspaced with cristobalite, a quartz polymorph that crystallizes in the tetragonal system. Although cristobalite itself has a crystalline structure, water molecules prevent the formation of a unified crystal lattice;

Opal-CT is common opal similar to Opal-C, but which contains spheres of both cristobalite and tridymite (a triclinic quartz polymorph);

Opal-A_N is the most abundant type of common opal and includes the hyalite subvariety. “A” signifies “amorphous”; “N” denotes a structure similar to that of volcanic glass;

Opal-A_G is precious opal. “A” signifies “amorphous”; “G” signifies a gel-like structure with attached water molecules surrounding layers of silica spheres that diffract light in a manner that creates opalescence.

Pure opal, regardless of variety, has no base color. Common opal is allochromatic (other-colored), meaning that its range of colors is due to traces of nonessential, chromophoric (color-causing) elements such as iron. Precious opal exhibits both allochromatic and idiochromatic (self-colored) properties; its body color is allochromatic, while its opalescent colors are idiochromatic and result from the manner in which light reflects from its internal structure, and not from the presence of chromophores.

The hyalite subvariety of common opal also exhibits both allochromatic and idiochromatic tendencies. Most hyalite is colorless and consists only of silica and water. But the subtle, pale-green, yellowish-green, and yellow hues of some specimens are thought to be caused by the presence of iron. Hyalite is one of the very few minerals or mineraloids that fluoresce in daylight. This pale, greenish-yellow fluorescence is idiochromatic and is caused by incident daylight energizing the electrons within the lattice. These electrons then release excess energy as greenish-yellow light. Hyalite’s daylight fluorescence and its intense ultraviolet fluorescence are both due to traces of the radioactive element uranium (U) in the form of the uranyl radical (UO₂)²⁺.

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COLLECTING LOCALITIES

Common and precious opal have many collecting localities worldwide. Sources of the hyalite subvariety of common opal are far fewer and include a recently discovered and as yet undisclosed locality in Zacatecas, Mexico (the source of our specimens); the Papruk Mine, Kamdesh district, Nuristan Province, Afghanistan; Parelhas in the Borborema Mineral Province, Rio Grande do Norte, Brazil; the Gouling-Keene Quarry, Dungannon Township, Hastings County, Ontario, Canada; the Ladaling uranium deposit, Jixi County, Xuancheng Prefecture, Anhui Province, China; Brná, Ústi nad Labem, Ústi Region, Bohemia, Czech Republic; the Skardu District, Baltistan, Pakistan; and Kriegalpin in the Binn Valley, Valais, Switzerland. In Japan, hyalite is collected at Satsuma-Loujima, Kagoshima Prefecture, Nansei Archipelago, Kyushu Region; and the Kenzan Mine in Okayama Prefecture, Chugoku Region, and Tawara in Gifu Prefecture, Chubu Region, both on Honshu Island.

In the United States, hyalite occurs at the White Knob Quarry in the Lucerne Valley Limestone District, San Bernadino County; and near Thousand Oaks in the Santa Monica Mountains, Ventura County, both in California. Other localities are the Colby Mine at Springfield, Sullivan County, New Hampshire; Hyalite Peak near Bozeman, Gallatin County, Montana; Spruce Pine, Mitchell County, North Carolina; Lewiston, Nez Perce County, Idaho; and Spor Mountain in the Thomas Range, Juab County, Utah.

JEWELRY & DECORATIVE USES

With its substantial hardness, range of pleasing colors, translucency, and opalescence, opal has served as a gemstone since antiquity. It is traditionally cut into cabochons to best display its colors. Opal gems usually weigh at least 3 carats and sometimes more than 20 carats. Because of the scarcity of gem-quality precious opal with sufficient thickness to fashion into traditional cabochons, cutters have developed composite gems called “doublets” and “triplets,” which consist of thin sections of precious opal cemented to colored backing material and protective surface layers. Opal was first synthesized in laboratories in 1900; synthetic opal was introduced commercially in the 1960s and is now mass-manufactured.

The hyalite variety of common opal has only recently gained popularity as a gemstone. Transparent hyalite is occasionally faceted into gems as large as three carats and mounted in rings. Because of its relatively low index of refraction (1.44-1.46), hyalite gems are not particularly brilliant; their appeal lies instead in their subtle color shifts when viewed in artificial light and in daylight. For most jewelry use, botryoidal hyalite is cut to shape and mounted in wrap or prong-type, silver settings for wear as pendants. These hyalite gems are not polished, but retain their natural, lustrous, bubble-like, botryoidal surface.

Hyalite specimens are collected for their lustrous sheen; distinctive, bubble-like, botryoidal surface structure; occasional hints of multicolored, surface iridescence; and unusual daylight fluorescence.

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HISTORY & LORE

Artifacts of both precious and common opal have been found in 6,000-year-old, African cultural sites. In Arabian folktales, precious opal fell from the heavens as flashes of lightning. The ancient Greeks believed that opal bestowed the power of foresight and prophecy upon its owner, while the Romans valued opal as a symbol of hope and purity. The Roman scholar Pliny the Elder (Gaius Plinius Secundus, A.D. 23-79) described opal as having “the living fire of the ruby, the glorious purple of the amethyst, the sea-green of the emerald, all glittering together in a wonderful play of light.” In medieval times, physicians administered tonics of finely ground opal to aid healing and prevent nightmares, and recommended prolonged gazing into opals to prevent eye disease. Also during the medieval era, Scandinavian women believed that wearing opal would keep their blonde hair from fading.

Many cultures believed that multicolored opal possessed unusually broad powers. To English dramatist and poet William Shakespeare (1564-1616), opal’s shifting, fiery colors symbolized unpredictability. In *Twelfth Night; Or, What You Will*, Shakespeare likened this opalescence to the changeability of the human mind, when the jester says to the mercurial Duke Orsino, “Now the melancholy God protect thee, and the Tailor make thy garments of changeable taffeta, for thy mind is opal.” Opal’s popularity suddenly plummeted in Europe during the early 1800s with the appearance of large quantities of inferior Russian opal, a stone that soon faded. Opal also figures prominently in the novel *Anne of Geierstein*, by Scottish author and poet Sir Walter Scott (1771-1832). In this novel, the main character wore a dazzling opal gem. But her existence became entwined with the opal’s beauty and as its fire faded, so, too, did her life—and that convinced many European readers that opal was unlucky. Until the discovery in the late 1800s of large Australian deposits, precious opal was quite rare. But the subsequent increased availability and affordability quickly restored its popularity. British Queen Victoria (Alexandrina Victoria, 1819-1901) also contributed to opal’s popularity by often wearing opal jewelry.

Opal has been featured on the Australian eight-cent and nine-cent stamps of 1973 and 1974, the \$1.20 stamp of 1995, and the \$2.50 stamp of 1998. It has appeared on the 600-franc stamp of Central Africa in 1998. Opal is the birthstone for the month of October. It is also Australia’s national gemstone, and one of Nevada’s two state gemstones.

Although known since antiquity, hyalite was long confused with similar appearing minerals. Hyalite was formally named as the transparent variety of common opal in the 1790s, after mineralogists realized that it differed from quartz by lacking a crystal structure. The name “hyalite” stems from the Greek word *hyalos*, meaning “glass” or “glassy,” an apt description of its appearance. Hyalite has acquired many alternative names, most of which allude to its water-like or glass-like appearance. These include “water opal,” “glass opal,” “jelly opal,” and “water stone.” Because of its unusual daylight fluorescence, in which its color changes in the light of day, hyalite is also known as “color-change opal.” Hyalite should not be confused with “hyalithe,” which is the trade name of a synthetic opaline glass.

According to metaphysical lore, opal wards off disease and enhances love between faithful lovers. However, because opal intensifies all thoughts and actions, including those that are

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negative, it must be worn judiciously. The only truly transparent variety of opal, hyalite is considered a scrying or divination stone that produces visions of both the past and future. These visions are reportedly preceded by the appearance of a bright, luminous, tunnel-like opening. Hyalite is thought to inspire creativity, enhance talent, and attract success; it also serves as a talisman for artists, healers, and philosophers.

MINERAL SPECIES: 5,000 . . . AND COUNTING

In recent decades, the number of formally recognized mineral species has grown dramatically. In spring 2015, that number officially topped 5,000. Keeping track of the steadily increasing number of minerals and assigning unique names to new species is the job of the International Mineralogical Association (IMA). The IMA was established in 1959, when the mineralogical societies of 16 nations joined together to bring order to the system of species recognition and naming. Since then, formal guidelines and a standardized review process have regulated the acceptance and naming of all new minerals, as well as the occasional discrediting of previously recognized minerals. These tasks are now handled by the IMA's Committee on New Minerals, Nomenclature and Classification (CNMNC).

Today, when researchers believe that they have identified a new mineral and that their chemical and physical data are correct, they propose a name for the mineral. But until the CNMNC confirms the chemical and physical validity of the new species and approves the proposed name, that mineral is identified only by a number. The CNMNC specifies that new mineral names must end in the suffix "ite" and must be based either upon their chemical composition or physical properties, relationship to other recognized species, type localities where the type specimens were collected, or some deserving person or organization. If the proposed name honors a person, the CNMNC prefers that the individual be someone with significant achievements in the fields of mineralogy, geology, or related sciences. A name becomes official only when the CNMNC has confirmed the validity of the new mineral and determined that its name does not conflict with any others among the more than 5,000 already-recognized mineral species.

This current system represents a vast improvement from the earliest days of naming minerals. Initially, the discoverer of a new mineral assigned a name that was based on obvious physical properties, uses, or sources. During this period, mineral names were considered "formalized" if they appeared in a scholarly work or simply became popular in general usage. Naming was an imprecise practice that was filled with errors; many early names referred not to a specific mineral in the modern definition of the term, but to varieties of the same species. Because some minerals thus had several "recognized" names, confusion was rampant.

As science began to replace alchemy, the emergence of analytical chemistry and crystallography, together with the identification of more chemical elements, greatly accelerated the recognition of new mineral species. The naming process grew somewhat more formal as researchers published descriptions of new minerals in scientific journals for international review and solicited comments on proposed names from their peers. Naming also became competitive, however, with scientists often rejecting proposed names in favor of their own preferences.

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When modern mineralogy emerged in the late 1700s, most new minerals were being named for their chemical compositions, physical properties, type localities or major occurrences. In 1789, the first mineral was named for a person, initiating a trend of naming new minerals for scientists and other individuals. The first orderly, mineral-classification systems appeared about 1800 and recognized less than 200 species. When German mineralogist Abraham Werner Gottlieb published his mineral-classification system in 1817, he recognized 317 species. By the mid-1800s, mineralogists had adopted the convention of ending all new mineral names in “ite,” a suffix derived from the Greek *lithos*, meaning “stone.” Advanced analytical methods enabled mineralogists to recognize new minerals faster than ever before and, by 1900, the number of species had surpassed 1,000.

In the early 20th century, the availability of X-ray diffraction analysis techniques further accelerated the rate of mineral identification. By the 1950s, 1,800 minerals had been identified, yet no central authority existed to regulate and approve their names, or to eliminate confusion and redundancy among the rapidly growing number of species. Only after establishment of the IMA in 1959 did mineralogists benefit from a workable system of recognizing, approving, and naming new minerals. In 1969, when *Fleischer's Glossary of Mineral Species* was first published, the number of species topped 1,900. (To prepare our write-ups, we continue to use *Fleischer's Glossary*, now in its 11th edition.) By January 2014, the number of species had soared to 4,680 and now, just a year later, it exceeds 5,000.

Looking at the origin of mineral names, roughly 48 percent are named for individuals, 25 percent for discovery localities, 15 percent for chemical compositions, and 8 percent for physical properties. Many of the remaining four percent of the names were assigned in antiquity; these include such species as silver, gold, galena, pyrite, and quartz.

Interestingly, of the more than 5,000 mineral species that are currently recognized, only about 100 provide collectible specimens, that is, specimens that would interest non-scientific collectors. All the others are either so rare, or occur in such small quantities, that they are not generally considered collectible.

It might seem that few new species remain to be recognized. But according to a recent article in *The Mineralogical Record*, another 1,500 species are still waiting to be identified, an estimate based on a complex statistical analysis of possible chemical combinations, along with both existing analytical methods and methods that are likely to be developed in the future. It seems very unlikely, however, that any additional “collectible” minerals will be discovered.

TECHNOLOGICAL USES

Opal has served as the model for its own laboratory synthesis.

ABOUT OUR SPECIMENS

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Our hyalite specimens were collected in Zacatecas in north-central Mexico. The state of Zacatecas, population 1.5 million, covers 29,067 square miles and is about the size of the American state of South Carolina. With an average elevation of 7,000 feet, it has a temperate, generally dry climate. Most of Zacatecas lies within the southern Sierra Madre Occidental where peaks rise as high as 10,500 feet. Zacatecas, which is richly mineralized, was the site of the first major silver discoveries made by Spanish prospectors in the early 1500s. Today, mining remains an important sector of the regional economy; Zacatecas accounts for most of Mexico's prodigious silver output, and also yields substantial quantities of lead, zinc, and gold.

The formation of our hyalite specimens began when a mass of silica-rich, rhyolitic magma intruded an existing body of granite. As the rhyolitic magma cooled, gases carrying silica and water migrated through the rhyolitic mass and into the adjacent, fractured granite. These gases accumulated within vugs, fissures, and fractures in the granite where reduced temperature and pressure caused the gas-phase silica to condense into silica gel on the fracture walls. With further cooling, this silica gel solidified into coatings of botryoidal hyalite.

The exact source of our hyalite specimens has not yet been revealed. Our specimens were collected somewhere in Zacatecas in 2013 and were first displayed at the Tucson Gem & Mineral Show in Tucson, Arizona, in February 2014, where their transparency and daylight fluorescence attracted considerable attention. As often happens in the mineral-specimen business, the locality has been kept secret to protect the site from other collectors.

As you examine your hyalite specimen, note first the matrix of altered granite. This is the host rock that was intruded by rhyolitic magma and altered by heat and contact with hydrothermal solutions and gases. Its basic structure, including individual crystals of quartz and feldspar, is still recognizable. The hyalite is present as a transparent, lustrous, bubble-like, botryoidal coating atop the altered granite. As you study the hyalite, slowly rotate the specimen to observe small, but bright, flashes of rainbow-like iridescence. This iridescence is caused by light reflecting from the multiple layers of silica at or near the surface; it should not be confused with the opalescence of precious opal, which is caused by reflections from an internal, silica-spherule structure.

Under both incandescent and fluorescent artificial light, the hyalite in your specimen appears almost colorless. But when viewed in daylight, the hyalite takes on a pale, distinct, greenish-yellow hue. This color is due to daylight fluorescence, a phenomenon rare in other minerals or mineraloids. This fluorescence does not occur in artificial light, the wavelength range of which is too narrow to energize the electrons within the hyalite. But the broader wavelength range of daylight does energize the electrons, which then release excess energy as visible, greenish-yellow light. Shortwave and long-wave ultraviolet light causes hyalite to fluoresce an intense green. Your hyalite specimen represents an unusual subvariety of common opal, and the only type of opal that is truly transparent.

References: *Dana's New Mineralogy*, Eighth Edition; *Encyclopedia of Minerals*, Second Edition, Roberts, et al, Van Nostrand Reinhold Company; *2014 Fleischer's Glossary of Mineral Species*, Malcolm E. Back; *Mineralogy*, John Sinkankas, Van Nostrand Reinhold Company; *Manual of*

